# REFRIGERATING APPARATUS FOR COOLING REFRIGERATING SPACES

## CROSS-REFERENCE TO RELATED APPLICATIONS

**[0001]** This application is a National Stage of International Application No. PCT/EP2004/011484, filed October 13, 2004, and which claims priority to German Patent Application No. 103 53 046.0, filed November 13, 2003. The disclosures of these applications are incorporated herein by reference.

## FIELD OF THE INVENTION

**[0002]** The present invention relates to a refrigerating apparatus, in particular for the cooling of refrigerating spaces, comprising two alternately activatable heat exchangers, in particular evaporators or coolers of a coolant circuit, and at least one fan to blow gas, in particular air, through the heat exchanger.

## BACKGROUND OF THE INVENTION

**[0003]** A refrigerating apparatus of the initially named kind is known from DE 197 09 176 C2. With this refrigerating apparatus, the two alternately activatable heat exchangers made with lamellae are arranged next to one another or over one another and are flowed through by the same flow of the medium to be cooled. This means that the two heat exchangers are each only charged by half of the flow. To achieve a desired charge with a medium flow, the total flow must therefore be selected to be twice as large. The fan must be

made correspondingly large, whereby the costs and the space requirements are increased.

## SUMMARY OF THE INVENTION

**[0004]** It is the underlying object of the invention to provide a refrigerating apparatus of the initially named kind which does not have these disadvantages. The refrigerating apparatus should in particular be cost favorable and space saving.

**[0005]** This object is satisfied in that the heat exchangers are arranged such that they can each be flowed through by the total gas flow of the fan at least on activation.

**[0006]** By the arrangement of the heat exchangers such that they can each be flowed through by the total gas flow of the fan, the required total gas flow can be reduced to approximately half with respect to the known apparatus. The fan must accordingly be dimensioned smaller, whereby costs and space are saved.

**[0007]** A flowing through of both heat exchangers by the total gas flow can in particular be achieved in that the two heat exchangers are arranged behind one another in the direction of flow. In this process, both heat exchangers can be arranged on the same side of the fan. Both heat exchangers are thereby automatically charged with the total gas flow, irrespective of the direction in which the fan blows.

**[0008]** Another arrangement consists of a first heat exchanger being arranged before the fan or fans in the direction of flow and a second heat

exchanger being arranged behind the fan or fans in the direction of flow. The two heat exchangers can thereby protect the fan from external influences.

**[0009]** A design is particularly cost favorable in which the heat exchangers are arranged freely in front of or behind the fan or fans. No additional components are thereby necessary and conventional heat exchangers can be used. Special products as with the initially named refrigerating apparatus are not necessary.

**[0010]** Gas conducting passages can, however, also be arranged between the fan or fans and the heat exchangers. A plurality of advantages hereby result. The heat exchangers and the fan can inter alia be arranged spaced from one another. In addition, pressure measuring devices such as pressure gages, filters or attenuators can be arranged in the gas conducting passages.

**[0011]** In accordance with a further embodiment of the invention, the fan or fans and the heat exchangers are also arranged in closed gas conductors. The flow generated by the fan can thereby be fully utilized and a good flow guidance can be achieved.

**[0012]** It is particularly preferred for the fan or fans and the heat exchangers to be arranged in a common housing. This is space saving, on the one hand, and also effects a good protection of the fan or fans by the heat exchangers exchanged in front and/or behind them.

**[0013]** Gas conducting passages can preferably be connectable to the housing at least at the gas outlet side. This advantageously permits the remote installation of the housing from the location to be cooled, for example

in the false ceiling of a refrigerating space or completely outside a building surrounding the refrigerating space.

**[0014]** In accordance with a particular embodiment of the invention, a fan with a reversible blowing direction is provided. By reversing the blowing direction of the fan, the direction of flow of the gas through the heat exchangers arranged in front of or behind the fan can be reversed, in particular such that the gas is sucked in by the respectively non-active heat exchanger and blown out by the respectively active heat exchanger. The non-active heat exchanger is thus flowed through by the gas to be cooled and is heated by it, which can advantageously be used for defrosting with evaporators of a coolant circuit when the temperature of the gas to be cooled is above freezing point. Subsequently, the gas thereby already cooled passes through the activated second heat exchanger, with it being further cooled in the desired manner.

**[0015]** One heat exchanger can thus always be defrosted and one used for cooling by an alternate activation of the two heat exchangers and a corresponding reversal of the blowing direction of the fan. This also has the advantage that the blowing out direction of the unit changes cyclically, whereby a better distribution of the cooled gas in the refrigerating space can be achieved. If, in contrast, a blowing out should always only be desired in one direction, this can be achieved by a suitable arrangement of gas conducting passages and valves in front of the outlets or inlets of the refrigerating apparatus.

**[0016]** In accordance with another embodiment, the different throughflow direction of the heat exchangers is realized by valve-controlled fluid guides.

**[0017]** With this embodiment, the gas can also be alternately sucked in by the one heat exchanger and blown out by the other heat exchanger, with the one heat exchanger respectively being inactive and optionally defrosted, whereas the other heat exchanger is activated for cooling. A reversal of the blowing direction is not necessary with this arrangement. A further advantage consists of the fact that the fan power can be optimized for the only blowing direction of the fan.

**[0018]** In accordance with a special embodiment of the invention, a fan is provided whose blowing side can alternately be connected via switch-over valves and corresponding gas conducting passages to the first heat exchanger or the second heat exchanger and its suction side to the respectively other heat exchanger. With this variant, the fan is therefore arranged between the two heat exchangers.

**[0019]** In accordance with another special embodiment, a fan is provided whose suction side is connected to the entry opening of the apparatus and whose blowing side is alternately connected to the first heat exchanger or to the second heat exchanger, with the respectively other heat exchanger being connected to the one heat exchanger, on the one hand, and to the outlet opening of the apparatus, on the other hand. In this variant, both heat exchangers are accordingly arranged in front of the fan or both heat exchangers are arranged behind the fan in the direction of flow.

**[0020]** In accordance with yet another special embodiment of the invention, two fans are provided which are arranged in opposite senses and parallel to one another and are each connected to the two heat exchangers via gas conducting passages and can be activated alternately. It can again also thereby be achieved that the gas to be cooled is alternately sucked in by the one heat exchanger and blown out by the other heat exchanger. In this process, one fan is active and the other fan is inactive respectively. The advantage is also present here that the fan power can be optimized for the only direction of flow.

**[0021]** The respectively non-active branch of this arrangement can preferably be closed via a valve. A false flow through the non-active branch can thereby be avoided.

**[0022]** In accordance with a particularly preferred embodiment of the invention, the inlet opening and the outlet opening of the apparatus are formed in each case by the same opening irrespective of the throughflow direction of the heat exchangers. The advantage thereby results that a filter attached behind the inlet opening is always flowed through in the same direction. No exchangeable filters therefore have to be provided, which permits a particularly good sealing of the filters. False air can hereby largely be avoided so that a high filter performance up to clean room engineering can be ensured.

**[0023]** It is likewise preferred for the inlet opening and the outlet opening of the housing always to be arranged at the same side of the apparatus, in particular next to one another. A particularly compact design of

the apparatus can thereby be achieved, whereby the space requirements can advantageously be reduced.

**[0024]** A further reduction in the space requirements can be achieved in that the fluid guides extend in different planes at least sectionally, in particular above one another and beneath one another, in accordance with a further embodiment of the invention. In addition, this variant is particularly advantageous when the inlet opening and the outlet opening are arranged on the same side of the apparatus.

**[0025]** It is furthermore advantageous for the diameter of the fluid guides to differ in different sections. The diameter can in particular be larger in the region of the heat exchangers than in front or behind them, for example in a ratio of approximately 2 : 1. The construction size can thus also be further reduced, without the performance capability of the apparatus being noticeably restricted since the cross-section can be kept advantageously large in the region of the heat exchangers and the reduced cross-section in another respect means hardly any impairment.

**[0026]** Axial fans can be used as fans in the refrigerating apparatus in accordance with the invention. However, radial fans can preferably also be used in the refrigerating apparatus in accordance with the invention. The latter have the advantage of a considerably higher pressing, which in particular comes into effect with the use of gas conducting passages.

**[0027]** The use of radial fans also permits the use of filters for the gas to be cooled. They can in particular be arranged in the gas conducting passages and/or in the fan housing. High hygiene demands can be satisfied by the use of filters.

**[0028]** In particular at least one rotary filter can be provided as the filter which is rotatable in dependence on the direction of flow of the gas. In this manner, the filter is always charged in the same direction by the gas flow. A blowing out of filtered particles again can thereby be avoided.

**[0029]** In accordance with a further embodiment of the invention, at least one roll filter is provided. The latter can, for example, be made as a disposable filter and can be further rotated accordingly on every reversal of the direction of flow.

**[0030]** In accordance with another embodiment of the invention, the filter roll can, however, also be made to be movable to and fro in a cyclic manner in dependence on the direction of flow of the gas. A respective section of the filter roll is thereby always charged with the gas flow in the same direction so that the blowing out of particles again can also be avoided here. On the reaching of a specific degree of load of the filter, the roll can then be rotated further by twice the filter length so that two new sections of the roll filter can be used alternately.

**[0031]** At least one pressure measuring device, in particular a pressure gage, can be arranged in the gas conducting passages and/or in the fan housing. It can be used both for the determination of the degree of icing of the heat exchangers and for the determination of the necessity of a change of filter.

**[0032]** A change of filter or a further rotation of a roll filter can, however, also be triggered or indicated at the end of a predetermined or predeterminable time, for which purpose corresponding means are provided in accordance with a further embodiment of the invention. A pressure measuring

device can thereby be saved. Good results can nevertheless be achieved on the basis of experience values.

**[0033]** The reversal of the direction of flow through the two heat exchangers can also take place in dependence on time, for which purpose suitable means are likewise preferably provided. Good results can also thereby be achieved on the basis of experience values and corresponding measuring devices such as pressure measuring devices for the detection of the degree of icing of the heat exchangers can be saved.

**[0034]** In accordance with a further embodiment of the invention, means for sterilization are provided in the gas conducting passages and/or in the fan housing, in particular in the region of the outlet opening. Hygienic demands can also thereby be satisfied, with the sterilization being particularly effective in the outlet region.

**[0035]** Means for UV irradiation or ionization can preferably be provided for the sterilization. Alternatively or additionally, it is also possible to provide means for the injection of disinfectants, for example fruit acid. Both measures are well suited for sterilization.

**[0036]** The two heat exchangers are generally operated alternately. In accordance with an embodiment of the invention, however, an overlapping operation is also possible by a corresponding control for the activation of the heat exchangers. An increased refrigerating capacity can be made available in the short term by such a control. The air humidity can additionally thereby be regulated.

**[0037]** Furthermore, sound attenuation devices in the fan housing or in the gas guides are advantageous. The noise radiation of the apparatus can thereby be reduced.

**[0038]** The speed of rotation of the fan or fans can advantageously be regulated for the regulation of the capacity of the refrigerating apparatus in accordance with a further embodiment.

**[0039]** An advantageous design results when the housing has a plurality of chambers. It is advantageous for service and repair purposes in this process if the chambers are each accessible via their own access opening, in particular a door.

**[0040]** It is furthermore advantageous for each chamber to have its own condensate drain. Service and repair measures can also be simplified in that a lighting device is provided in the housing.

**[0041]** Further areas of applicability of the present invention will become apparent from the detailed description provided hereinafter. It should be understood that the detailed description and specific examples, while indicating the preferred embodiment of the invention, are intended for purposes of illustration only and are not intended to limit the scope of the invention.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0042]** Non-restricting embodiments of the invention are shown in the drawings and will be described in the following. There are shown, schematically in each case:

**[0043]** Fig. 1 a block diagram of a first variant of the refrigerating apparatus in accordance with the invention;

**[0044]** Fig. 2 a representation in accordance with Fig. 1 of a second variant;

**[0045]** Fig. 3 a representation in accordance with Fig. 1 of a third variant;

**[0046]** Fig. 4 an upper view of a fourth variant of the refrigerating apparatus in accordance with the invention;

**[0047]** Fig. 5 a perspective view of the variant of Fig. 4 from a first direction of view; and

**[0048]** Fig. 6 a perspective view of the same apparatus from a second direction of view.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

**[0049]** The following description of the preferred embodiment is merely exemplary in nature and is in no way intended to limit the invention, its application, or uses.

**[0050]** Fig. 1 shows a fan 1, two heat exchangers 2 arranged at both sides of the fan 1 as well as two filters 3 arranged in each case on the side of the two heat exchangers 2 remote from the fan 1. Gas guides 4 are present between the fan 1 and the heat exchangers 2 and the filters 3, with these being able to consist of passages or lines. The fan 1 and the heat exchangers 2 as well as preferably also the filters 3 can, however, also be arranged in a common housing which then ensures the schematically shown gas guidance between the named components.

**[0051]** In addition, two pressure gages 5 are shown via which the pressure can be detected on both sides of the fan 1. A pressure gage 5 of this type can be arranged both in the region of the filters 3, as shown, to be able to draw a conclusion on the degree of load of the filters 3, and in the region of the heat exchangers 2 to be able to draw a conclusion on their degree of icing. To be able to detect both, a plurality of pressure gages 5 can also be provided on each side.

**[0052]** The fan 1 is made as a radial blower whose direction of rotation can be reversed. In this manner, a gas flow can be generated both in the direction of the arrow 6 and in the reverse direction in accordance with arrow 7. The switch-over can take place in dependence on the degree of icing of the heat exchangers 2 or in dependence on time. A corresponding control is provided, but not shown.

**[0053]** The filters 3 can be made as rotary filters, in particular as bag filters rotatable around 180°. The rotary position can be set according to the blowing direction of the fan 1 via a suitable control so that the filters are always charged by the gas flow 6 or 7 in the same direction and the particles absorbed by the filters 3 are not blown out again when the direction of rotation of the fan 1 reverses. The filter 3 on the outflow side could, however, also simply be moved out of the flow since it is often sufficient for the filter 3 on the suction side to be active.

**[0054]** Roll filters with which filter material can be wound off a roll can also be used instead of bag filters. If the roll filter is made as a disposable filter, it is respectively wound off the roll by a corresponding length on the reversal of direction of the fan 1. However, a multifilter can also be used with

which the control winds the filter on and off cyclically so that always the same section of the filter is active in the one and the other blowing direction 6, 7 of the fan 1. The control can furthermore be made such that on a specific degree of loading of the filter the roll is further rotated so far that two new sections are available for the rolling onto and off the roll.

**[0055]** The necessity of a change of filter or of a further rotation of a roll filter can be detected via a suitable control in dependence on the pressure. The control can indicated this and/or initiate an automatic change or an automatic further rotation of the filter.

**[0056]** The necessity of a filter change can, however, also be detected by the passing of time instead of via the pressure. The time span in particular results from experience values and can be preset. The time span can, however, also be changeable and be predetermined by the user.

**[0057]** The heat exchangers 2 can be made with lamellae as is described, for example, in DE 19709 176 C2. In another respect, conventional heat exchangers can, however, also be used such as are also used for simple fans blowing only in one direction. Conventional fans of this type can also be used for the fan 1.

**[0058]** In the variant shown in Fig. 2, the direction of rotation of the fan 1 is not reversible. Instead, the fan 1 is respectively connected to the two heat exchangers 2 via two alternative paths 4a, 4b and 4c, 4d. In each of these four sections 4a, 4b, 4c, 4d, a closing valve 8 is arranged which is opened or closed depending on the desired direction of flow of the gas flow 6 or 7.

**[0059]** To effect a flow in accordance with the arrows 6, the valves 8 in the sections 4a and 4d are open and those in sections 4b and 4c are closed. Accordingly, to effect a flow in accordance with the arrows 7, the valves 8 in the sections 4b and 4c are open and those in sections 4a and 4d are closed. The fan 1 is here also preferably made as a radial blower, with it now, however, being able to be optimized better due to the single direction of rotation. In other respects, the design of this variant can be identical to the one previously described. The mode of operation is also identical with the exception of the switching over of the valves 8.

**[0060]** In the variant shown in Fig. 3, two fans 1a and 1b are provided which are arranged parallel to one another and with opposite directions of rotation in a respective part section 4e, 4f of the gas guide 4. The one fan 1a or the other fan 1b is switched on in dependence on the desired direction of flow 6 or 7. A flow is in particular generated in the direction of arrow 6 by switching on the fan 1a and closing the section 4f and a flow in the direction of arrow 7 by switching on the fan 1b and closing the section 4e. The respective section 4e or 4f with the non-active fan 1a or 1b is closed via closing valves 9 in the two sections 4e and 4f to avoid a false flow.

**[0061]** The two fans 1a and 1b are in turn preferably made as radial fans and are optimized for their respective direction of flow. In other respects, the apparatus can also be made in the same manner as with variant 1 here. The operating mode is also identical to that of variant 1 with the exception of the alternate activation of the two fans 1a and 1b and the closing of the respectively other section 4f or 4e.

**[0062]** The variant shown in Figs. 4 to 6 includes a housing 10 with an inlet opening 11 and an outlet opening 12. A filter 3 is arranged behind the inlet opening 11 and behind it a fan 1 not reversible in its direction of rotation. The suction side of the fan 1 faces the inlet opening 11 of the housing 10. The blowing side of the housing 1 is adjoined by a valve 13 and behind this the two heat exchangers 2.

**[0063]** The housing 10 is divided by a partition wall 14 into two regions 15 and 16 which are in turn divided into a plurality of chambers 18 by partition walls 17. The filter 3 is arranged in a first chamber $18^1$ behind the inlet opening 11 of the housing 10. It is followed by a chamber $18^2$ which is separated from the first chamber by a partition wall $17^1$. The partition wall $17^1$ has a passage opening 19 to which the suction side of the fan 1 is connected.

**[0064]** The chamber $18^2$ with the fan 1 is bounded on the other side by a partition wall $17^2$ in which the valve 13 is provided. As can in particular be recognized in Fig. 5, the height of the valve 13 amounts approximately to half the height of the partition wall $17^2$.

**[0065]** The partition wall $17^2$ bounds a further chamber $18^3$ with the first heat exchanger $2^1$; the first heat exchanger $2^1$ a chamber $18^4$ with the second heat exchanger $2^2$; and the second heat exchanger $2^2$ a further chamber $18^5$ with the housing 10. All chambers $18^1$ to $18^5$ are located in the first housing section 15.

**[0066]** As can in particular be recognized in Fig. 6, a chamber $18^6$ and a chamber $18^7$ are formed in the second housing section 16 by a two-fold angled partition wall $17^3$. The chamber $18^6$ is connected to the chamber $18^5$ via an opening 20. A further connection of the chamber $18^6$ is present via a

valve 21 to the chamber $18^2$ in which the fan 1 is located. The chamber $18^7$ is connected to the chamber $18^3$ via a further valve 22 and to the chamber $18^6$ via a further valve 26.

**[0067]** The angled partition wall $17^3$ has a first vertical section 23 which is connected to the upper side of the housing 10, a horizontal section 24 adjoining it and a second vertical section 25 which adjoins the latter and is connected to the base of the housing 10. The height $h_1$ of the second vertical section is approximately half the size of the height $h_2$ of the first vertical section. In addition, the further valve 26 is provided in the second vertical section 25.

**[0068]** All the chambers 18 of the housing 10 are provided with their own condensate drain as is indicated by jagged arrows 27. In addition, the chambers are accessible, in particular for maintenance and repair work, via doors 28. Furthermore a UV radiation device 29 is provided in the chamber $18^6$ and the medium guided through the apparatus can be sterilized by it. Finally, a lighting can be provided in the housing 10.

**[0069]** In the variant shown in Figs. 4 to 6, the inlet opening is always formed independently of the throughflow direction of the two heat exchangers $2^1$ and $2^2$ by the opening 11 and the outlet opening is always formed by the opening 12 of the housing 10. To nevertheless permit a changing throughflow of the two heat exchangers $2^1$ and $2^2$, the valves 17, 21, 22 and 26 are provided. The valves 17 and 26 are open, the valves 21 and 22 closed, in contrast, for the throughflow of the apparatus in the first direction marked by the arrow 6. The gas flow sucked in through the fan 1 moves from the inlet opening 11 via the filter 3 into the chamber $18^1$ and from there into

the chamber $18^2$. Then the gas flow moves through the valve 13 into the chamber $18^3$, flows through the first heat exchanger $2^1$, which is inactive in this case and is defrosted by the warm gas flow, then into the chamber $18^5$, then through the active heat exchanger $2^2$ by which the gas flow is cooled and then into the chamber $18^5$. From there, the gas flow moves via the opening 20 in the wall 14 into the chamber $18^6$ in which the gas flow is sterilized by the UV radiation device 29. The gas flow then flows through the valve 26, moves into the chamber $18^7$ and moves from there via the outlet opening 12 out of the housing 10 of the apparatus.

**[0070]** On the reverse operation of the apparatus in accordance with arrow 7, the valves 17 and 26 are closed, whereas the valves 21 and 22 are open. The gas flow sucked in by the fan 1 now no longer moves from the chamber $18^2$ into the chamber $18^3$ since the valve 13 is closed, but rather via the valve 21 into the chamber $18^6$. From there, the gas flows on through the opening 20 in the wall 14 into the chamber $18^5$, flows through the second, now inactive heat exchanger $2^2$, with this being defrosted, further into the chamber $18^4$, then through the first, now active heat exchanger $2^1$ which cools the gas flow and then into the chamber $18^3$. Since the valve 13 is closed, the gas flow moves from the chamber $18^3$ via the valve 22 into the chamber $18^7$ and flows out from there via the outlet opening 12 of the housing 10. The gas is also sterilized by the UV radiation device 29 in the chamber $18^6$ in this operating direction. Instead of the arrangement of the radiation device in chamber $18^6$, it can also be arranged in chamber $18^7$, that is in the region of the outlet opening 12.

**[0071]** As can be recognized, the two heat exchangers $2^1$ and $2^2$ can selectively be flowed through in the one or the other direction 6, 7 in accordance with the operating mode described. A large cross-section of the heat exchangers and, on the other hand, a relatively low housing size overall is realized by the ratio of the housing section 15 to the housing section 16 of approximately 2 : 1. The cross-section changes thereby occurring have no disadvantageous influence on the flow.

**[0072]** In all the variants shown, both heat exchangers 2, which can in particular be the evaporator or cooler of a coolant circuit, are flowed through by the total gas flow of the fan 1 or of the fans 1a, 1b. This means that gas is sucked in by the one heat exchanger 2, which is then not activated, and is blown out by the other heat exchanger 2, which is activated. If the first heat exchanger 2 is iced, the sucked in gas is already cooled. With gas having a temperature above freezing point, the first heat exchanger 2 is thereby defrosted without any electrical or other defrosting equipment being necessary. The gas is further cooled in the desired manner in the active, second heat exchanger.

**[0073]** After reaching a specific degree of icing of the second heat exchanger 2 or after a predetermined extent of time, the flow direction is switched over in that, in the case of the variant of Fig. 1, the direction of rotation of the fan 1 is switched over. In the case of the variant of Fig. 2, the valves 8 are switched over for this purpose from their open position into their closed position and from their closed position into their open position. And in the case of the variant of Fig. 3, when the fan 1a was first switched on, it is switched off and the other fan 1b is switched on and the closed valve 9 is

opened and the open valve 9 is closed. If, on the other hand, the fan 1b was switched on, the switch-over takes place in reverse accordingly. The switching over in the variant of Figs. 4 to 6 has already been described above.

**[0074]** In all cases, an overlapping operation is also possible in which both heat exchangers 2 are active for a specific period of time. The refrigerating capacity can thereby be increased in the short term, on the one hand, and the humidity content of the gas can thereby be regulated, on the other hand.

**[0075]** Filters 3, gas conducting passages 4 and also noise attenuation devices can be used due to the use of a radial fan with which a much higher pressing can be realized than with an axial fan. The noise of the refrigerating device can thereby be advantageously reduced.

**[0076]** In addition, means can be provided in the fan housing for sterilization, such as UV radiation, and means for the injection of disinfectant, such as fruit acid.

**[0077]** The description of the invention is merely exemplary in nature and, thus, variations that do not depart from the gist of the invention are intended to be within the scope of the invention. Such variations are not to be regarded as a departure from the spirit and scope of the invention.